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Compost mulch no-tillage systems in organic vegetable production

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With growing agricultural demands from both conventional and organic systems comes the need for sustainable practices to ensure long-term productivity. In Hungary small scale vegetable growers face challenges in producing their crops due to the lack of effective weed control practices and viable methods of sustainable soil fertility management based on local or regional soil amendment resources. There is a demand for cultural practices that reduce hand labor requirements and black plastic mulches whereas long-term productivity is held or increased. To identify effective alternative weed control and soil fertility management options for the management of intensive organic vegetable systems, our research focuses on the evaluation of compost and paper mulches, in conjunction with reduced-tillage practices. In 2015 determinate tomato (cv. Roma) is grown in five different soil treatments using yard waste compost (YWC) mulch and combination of YWC and paper mulch (PM) plus bare ground control under intensive and reduced tillage variants to evaluate their effectiveness on organic tomato marketable yield and weed suppression. Since most organic tomatoes at present are grown on small acreage in Hungary, and are direct-marketed, the application of organic mulches can be assumed financially feasible. Our results will show if the combination of organic mulching materials together with reduced tillage may be a viable option for organic vegetable growers.

Keywords: alternative weed control, compost, compost mulch, paper mulch, organic, no tillage, vegetable, tomato

1 Introduction

The objective of this publication is to review the effects of composted organic mulches, and the combination of mulches and different tillage intensity systems as alternative weed control methods and viable soil fertility management solutions. Practices for vegetable and fruit production need to focus on decreasing synthetic inputs, sustainably managing disease and weed control, reducing soil erosion, and maintaining soil structure while producing high-quality fruit and profitable yields (Grassbaugh et al. 2004). Although research on the benefit and use of mulches is extensive, little is known about how to optimize their application in organically managed system (Law et al. 2006).

1.1 Weed control

Production losses from weed competition are among the most important crop management concerns for organic growers, and the ability to control weeds is considered a major limiting factor for farmers wishing to transition to organic production systems (Bond and Gandy 2001). Organic vegetable production relies heavily on intensive tillage to reduce weeds and to create a fine seedbed for planting or seeding. This intensive tillage has been shown to be detrimental to long term soil quality, and often leads to contamination of the environment through on-site and offsite losses of organic matter, nutrients and sediments (Magdoff and van Es, 2000). It also reduces soil microbial activity, destructs soil structure, while increasing emission of greenhouse gases, and the potential for nitrate leaching to groundwater (Jackson et al. 2003). Reduced tillage systems are spreading practice especially on the American continent, largely as a result of growing concerns about soil quality, costs of tillage

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operations, fossil fuel and labor use, and environmental resources. On the other hand, decreased intensity of tillage may cause serious problems for growers because of increased weed pressure.

1.2 Organic mulches

Application of organic mulches is an alternative method to suppress weeds through blocking light and prevent weed establishment without mechanical or manual weeding (Brault et al. 2002) and can be as effective as herbicides in suppressing weeds (Ozores-Hampton, 1998). Organic mulches such as straw, wood chips or compost can conserve soil moisture, reduce soil erosion and may also have advantages of low-cost, with no removal requirement compared to black polyethylene mulch, commonly used among organic growers (Ozores-Hampton 1998; Feldman et al. 2000). These mulches have also been shown to improve soil quality and stimulate soil microbial communities due to the addition of organic matter. Possible disadvantages of organic mulches include nutrient tie-up and lowering, if soil temperatures decrease to sub-optimum level (Schonbeck and Evanylo, 1998). Also, organic mulch alone is not always sufficient to control perennial weeds, and may even pose a risk of weed infection, especially if its material of origin contained weed propagules, and was not fully hot composted (Merfield, 2002). Straw and hay mulches improve soil properties degradation and are used widely. However, they keep soil cooler which can delay early season growth. Surface-applied yard waste compost (YWC) substantially increases underlying soil nutrient levels (Feldman et al., 2010) and also increases yields (Gallaher and McSorley, 1994), whereas it does not have a cooling effect on the soil due to its dark colour. Composting is a biological decomposition process in which microorganisms convert organic materials into relatively stable humus like material. During decomposition, microorganisms assimilate complex organic substances and release inorganic nutrients. An adequate composting process should kill pathogens and stabilize organic carbon before the material is applied as mulch. The end-product of the composting process is optimal as soil amendment and mulch as well. YWC is easily accessible in many regions in Hungary where there are composting operations next to landfills.

1.3 Paper mulch

Paper mulches may offer another viable solution for weed control without the problem of disposal of plastic mulches, since they decompose fully after use (Radics and Bognár, 2004; Merfield 2002). Paper mulch as soil cover for special agricultural use is even produced and used in commercial scale in some countries and is a permissible product for weed control in organic farming certification systems (Harrington and Bedford, 2004). Its main disadvantage is rapid degradation; it tends to tear from the edges, may be lifted by wind and degrades too quickly, resulting in a high weed population on the field where applied. No scientific study analyzed an integrated approach where paper mulch and compost mulch is applied at the same time, on the same bed. According our hypothesis if paper mulch is covered by weed seed free compost and vegetable seedlings are transplanted into this mulch layer, the advantages of both mulch types may be utilized. Paper mulch effectively suppresses weed emergence during the first several weeks after transplanting, and the weed-free compost serves as optimal media for transplants. If drip irrigation applied, the sodden paper mulch will be penetrable for the growing roots of the vegetable plant, so it can reach the soil under the paper mulch ensuring its continuous development.

2 Material and Methods

Five tillage and organic mulch treatments (Table 1) in four replications are compared in a randomized complete block design in frame of a small scale organic vegetable production system. Treatments are compared regarding their weed control efficacy, effect on soil properties and influence on yields. YWC, PM and CM are applied by hand.

Each plot comprises of a 15 m long and 1,2 m wide bed that was prepared on a clay loam Luvisoil at the MagosVölgy Organic Farm, Terény, Hungary. In late April 2015 each plot was

planted with tomato seedlings (cv. Roma), using three rows of plants 40 cm apart and with 40 cm spacing within the rows. Weed infestation will be measured using 1 x 1 m quadrates in four replications and four times per plot, assessed by counting number of weeds and coverage of plants. Height and development of tomato plants in different phenological phases after transplanting will be measured as well, as total plant biomass (dry weight) after the harvest season. Crop yields will be measured throughout the harvesting season several times according to the fruit ripening from 20 selected plants from the middle row of the beds. The YWC purchased from the Zöld-Híd Nonprofit Ltd. Company's Nógrádmárcfal Facility will be analyzed for dry matter, organic matter, C, N, P, K and pH, and minerals before application using standard procedures.

Table 1 Treatment specification

Treatment no.	Tillage	Mulch applied	N source (kg ha)
Treatment 1	conventional	none	pelleted chicken manure (CM)
Treatment 2	conventional	none	YWC (120) + CM (30)
Treatment 3	conventional	yard waste compost	YWC (120) + CM (30)
Treatment 4	reduced tillage	yard waste compost	YWC (120) + CM (30)
Treatment 5	reduced tillage	yard waste compost	YWC (120) + CM (30)

3 Results

Preliminary results for weed infestation and yield will be available in November 2015 and will be published.

4 Conclusions

In literature no relevant scientific data has been found on mixed application of paper mulch and compost mulch on small scale, intensively managed organic vegetable production systems. According to the data available, and based on some practical (unstudied) examples of successful vegetable operations in California (US), it is assumed that a combined system of compost mulch and paper mulch methods may be competitive in terms of weed control and tomato yields, compared with conventionally tilled uncovered systems. First results of the study will be presented at ICOAS 2015.

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